UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

SAFETY PARAMETER DISPLAY SYSTEM

OCONEE NUCLEAR STATION, UNITS 1, 2 AND 3

DOCKETS NOS. 50-269, 50-270 AND 50-287

I. INTRODUCTION

All holders of operating licenses issued by the Nuclear Regulatory Commission (licensees) and applicants for an operating license (OL) must provide a Safety Parameter Display System (SPDS) in the control room of their plant. The Commission approved requirements for the SPDS are defined in Supplement 1 to NUREG-0737.

The purpose of the SPDS is to provide a concise display of critical plant variables to control room operators to aid them in rapidly and reliably determining the safety status of the plant. NUREG-0737, Supplement 1, requires licensees and applicants to prepare a written safety analysis describing the basis on which the selected parameters are sufficient to assess the safety status of each identified function for a wide range of events, which include symptoms of severe accidents. Licensees and applicants shall also prepare an Implementation Plan for the SPDS which contains schedules for design, development, installation, and full operation of the SPDS as well as a design Verification and Validation Plan. The Safety Analysis and the Implementation Plan are to be submitted to the NRC for staff review. The results from the staff's review are to be published in a Safety Evaluation Report (SER).

Prompt implementation of the SPDS in operating reactors is a design goal of prime importance. The staff's review of SPDS documentation for operating reactors called for in NUREG-0737, Supplement 1 is designed to avoid delays resulting from the time required for NRC staff review. The NRC staff will not review operating reactor SPDS designs for compliance with the requirements of Supplement 1 of NUREG-0737 prior to implementation unless a pre-implementation review has been specifically requested by licensees. The licensee's Safety Analysis and SPDS Implementation Plan will be reviewed by the NRC staff only to determine if a serious safety question is posed or if the analysis is seriously inadequate. The NRC staff review to accomplish this will be directed at (a) confirming the adequacy of the parameters selected to be displayed to detect critical safety functions, (b) confirming that means are provided to assure that the data displayed are valid, (c) confirming that the licensee has committed to a human factors program to ensure that the displayed information can be readily perceived and comprehended so as not to mislead the operator, and (d) confirming that the SPDS will be suitably isolated from electrical and electronic interference with equipment and sensors that are used in safety systems. If, based on this review, the staff identifies a serious safety question or seriously inadequate analysis, the Director of IE or the Director of NRR may require or direct the licensee to cease implementation.

II. SUMMARY

The staff reviewed the SPDS Safety Analysis Report for Oconee, Units 1, 2 and 3 and concludes that it is acceptable for the licensee to continue implementing its SPDS Program. The staff finds the parameter selection for Oconee's SPDS to be acceptable, but recommends the addition of several parameters to enhance the operator's ability to evaluate the status of safety functions during unique plant accident scenarios. The information needed by the staff to conduct a confirmatory review is defined herein.

III. EVALUATION

Duke Power Company (DPC) submitted for staff review a Safety Analysis Report and Implementation Plan on the SPDS for the Oconee Nuclear Station, Units 1, 2 and 3 (Reference 1). In response to a staff request, DPC subsequently provided further information regarding the Oconee SPDS (Reference 2).

References 1 and 2 describe the display system, provide the design bases for the system, discuss parameter selection and display formats, describe the human factors considerations used in the design and the Verification Validation Plan for the design. The staff's review of the licensee's SPDS submittals is presented in the text which follows.

A. SPDS DESCRIPTION

The system proposed by the licensee is a software implementation on the plant computer with certain upgrades to the central processing units and displays. The primary display format consists of six color-coded status blocks representing the status of the licensee-defined critical safety functions (CSFs): (a) subcriticality, (b) inadequate core cooling, (c) heat sink, (d) RCS integrity, (e) containment integrity, and (f) RCS inventory. Two further levels of supporting displays are available in a status tree format. Second-level displays provide status trees that include details about the parameters that affect the status of each CSF block, e.g., "feedwater unavailable." Third-level displays indicate the plant field inputs that affect parameters, e.g., "emergency feedwater pump A not in service."

The licensee defines the information contained in the second and third levels as being outside the scope of SPDS. The staff does not agree and, for purposes of this review, has considered the Oconee SPDS to include the primary display and those supporting displays that provide the access for the "safety function variables" identified in Table 1.

B. PARAMETER SELECTION

Section 4.1.f of Supplement 1 to NUREG-0737 states that:

"The minimum information to be provided shall be sufficient to provide information to plant operators about:

(i) Reactivity control

(ii) Reactor core cooling and heat removal from the primary system

(iii) Reactor coolant system integrity

(iv) Radioactivity control

(v) Containment conditions."

For review purposes, these five items have been designated as Critical Safety Functions.

In the evaluation of the SPDS variables the staff has considered the Oconee "Abnormal Transient Operating Guidelines" (ATOGs), which were reviewed and approved by the Staff (Reference 3), as a principal technical source of variables important to operational safety. The SPDS variables selected by the licensee and the licensee-defined CSFs are summarized in the attached Table 1 (grouping made by licensee).

The staff has reviewed the licensee's Safety Analysis Report on the Oconee SPDS. The staff finds that the variables selected comprise a generally comprehensive list, but notes that the following variables appear to be omitted:

1. RCS Level (if available)
2. Hot Leg Temperature
3. Cold Leg Temperature

RCS Level is a key indicator of adequate primary system inventory for the "Core Cooling and Heat Removal" safety function. Although Reference 1 indicates that reactor vessel level and hot leg "level" indications will be included in the logic for the SPDS following installation of these systems, it is not clear that reactor vessel level will be displayed on the SPDS. This should be clarified. Hot leg temperature and cold leg temperature are key indicators used in ATOG (Part II, Volume I, Appendix B) to determine the viability of natural circulation as a mode of heat removal. Additionally, with regard to the RCS Integrity Critical Safety Function, cold leg temperature in conjunction with RCS pressure are key variables for brittle fracture considerations. It is not clear from Reference 1 whether hot leg temperature is proposed. Cold leg temperature is not mentioned.

The above variables do, for given scenarios, provide unique inputs to determinations of status for their respective CSFs, which have not been discussed by the licensee as being satisfied by other variables in the proposed Oconee SPDS List.

Based on this review of the licensee's supporting analyses, and the observation that the selected variables appear to be consistent with the approved Oconee ATOGs, the staff finds the proposed list of key variables to be generally acceptable, with exceptions noted above.

Finally, design flexibility should be provided for possible future expansion of the SPDS. For example, since the current version of ATOG was written to apply only to power operation, other key variables may be identified to assess the safety status of the CSF if the ATOG is modified for other plant operation modes.

Information Needed for Confirmatory Review.

The licensee should provide a response to the staff's recommendation to add RCS Level, Hot Leg Temperature and Cold Leg Temperature: (1) by adding these variables to the Oconee SPDS, (2) by providing alternate added variables along with justification that these alternates accomplish the same safety functions for all scenarios, or (3) by providing justification that variables

currently on the Oconee SPDS do in fact accomplish the same safety functions for all scenarios.

The licensee should identify the variable(s) used to monitor the system status parameters represented on the SPDS, e.g., "Low Pressure Injection System."

The licensee should discuss how radiation in the secondary system (steam generators and steamlines) is monitored on SPDS when the steam generators and/or their steamlines are isolated.

C. DISPLAY DATA VALIDATION

The staff reviewed the DPC submittals to determine that means are provided in the design to assure that the data displayed are valid. The Oconee design provides several checks on data validity depending on the number of sensors available for input. All computer analog inputs undergo a range check. When more than one sensor is available for input, the data points are logically combined, giving more weight to data closer to alarm setpoints. In addition, other conditions that affect data validity are monitored and logically integrated into the final determination of validity, e.g., out-of-scan, out-of-service, blown fuse. The licensee is currently working with other utilities on a Utility Advisory Group formed to provide project direction to the Electric Power Research Institute (EPRI) Research Project RP-2292-1, "Validation and

Integration of Critical PWR Signals." According to DPC the purpose of the project is to develop a methodology and a system of computer software for on-line validation of signals for use in nuclear power plants. The project scope is specifically aimed at validation methodologies using physical and/or analytical redundancy.

Based on the use of physical redundancy and software based monitoring and conditioning logic, the staff confirms that means are provided in the SPDS design to assure that the data displayed are valid. However, it is not clear that the methods used for data validation are comprehensive in terms of validation of all SPDS inputs or in terms of validation over all emergency conditions (e.g., those postulated in the reanalysis of transients done in response to Task Action Plan Item I.C.1).

The staff encourages the licensee's efforts in the described EPRI project. A commitment to physical and/or analytical validation for all SPDS inputs would be acceptable to the staff.

D. HUMAN FACTORS PROGRAM

The staff evaluated the DPC submittal for a commitment to a Human Factors Program in the development of the SPDS. As evidence of the licensee's commitment to a human factors program, the staff noted several aspects of the design process. First, the design was developed taking into consideration various human factors guidance

documents published by the NRC, EPRI, and the Institute of Nuclear Power Operations (INPO). Secondly, the team that is conducting the Oconee Control Room Design Reviews will review the SPDS, its supporting displays and hardware. The SPDS will be subjected to a static survey and to a review of SPDS operations during simulated alarm conditions.

The useability and effectiveness of the displays will be evaluated using a set of pre-selected task analysis principles. These principles will cover such items as logical ordering of displays, terminology and abbreviations, labeling, coding, usability of displayed information, and operator task support. In general, the task analysis activity will evaluate the SPDS and supporting displays to determine if the displays provide a logical, readily useable format to support the following operator tasks:

- Monitor Critical Safety Function Status (CSF)
- Observe CSF status changes
- Determine which CSF is degraded
- Determine severity of degradation
- Identify component/functional area out-of-tolerance
- Determine which confirming displays and restoration procedures to use

- Monitor restoration progress
- Monitor remaining CSF status during restoration.

Based on these observations, the staff confirms that DPC did commit to a human factors program in the design of the Oconee SPDS.

E. ELECTRICAL AND ELECTRONIC ISOLATION

The staff evaluated the DPC Safety Analysis for confirmation that the SPDS will be suitably isolated from equipment and sensors that are used in safety systems. The SAR did not address the issue. On August 24, 1984, a request for additional information was sent to the licensee. Additional information on SPDS isolation was submitted by letter dated October 18, 1984.

This evaluation addresses the qualification and documentation of the isolation devices between Class 1E safety-related systems and the SPDS.

The existing Oconee computer system, the Operator Aid Computer System (OACS), is being upgraded with the installation of new Honeywell 45000 central processing units (CPU), with additional input capacity to provide computing capability needed to implement the SPDS. The existing computer interface which was part of the original plant design is being retained, including previously reviewed and accepted isolation devices. These devices are

described in Oconee FSAR Section 7.2.3.3. The original design implemented Bailey model 880 isolators and contact to coil relays as isolation between safety-related systems and the OACS. Duke Power stated that they are only using the existing OAC input system to interface with the new Honeywell 45000 CPU. As such, no new isolation devices will be incorporated in the replacement process of the old OAC.

Based on a review of the documentation received on the Oconee SPDS upgrade, the staff concludes that the devices previously reviewed and accepted as part of the original plant design are qualified isolators and are acceptable for interfacing the SPDS with safety systems, and, further, that this equipment meets the Commission's requirements in NUREG-0737, Supplement No. 1.

IV. CONCLUSIONS

The NRC staff reviewed the Oconee SPDS submittals (References 1 and 2) to confirm the adequacy of the parameters selected to be displayed to monitor critical safety functions, to confirm that means are provided to assure that the data displayed are valid, to confirm that the licensee has committed to a Human Factors Program to ensure that the displayed information can be readily perceived and comprehended so as not to mislead the operator, and to confirm that the SPDS is suitably isolated.

Based on its review, the staff concludes that no serious safety questions are posed by the proposed SPDS and, therefore, implementation may continue.

This conclusion is based on the following:

1. The variables selected for display are generally adequate to assess critical safety functions, except for the omissions identified in Section III B of this SER.

2. The licensee has stated that the SPDS will be suitably isolated from plant safety systems.

3. The licensee's design provides means to assure that displayed data are valid.

4. The licensee has committed to conduct a human factors engineering program which will allow reasonable assurance that the information provided will be readily perceived and comprehended by its users.

The conclusion that SPDS implementation may continue does not imply staff confirmation that the SPDS meets the requirements of Supplement 1 to NUREG-0737. Such confirmation can be made only after a

post-implementation review or when the staff has otherwise obtained sufficient information.

The continued implementation of the SPDS by the licensee is conditional to a satisfactory confirmatory review by the staff on the design information requested from the licensee in Section III.B of this Safety Evaluation Report.

Dated: June 4, 1985

Principal Contributor: G. Lapinsky

V. REFERENCES

1. Letter from Duke Power Company to NRC dated February 16, 1984 forwarding "Response to Supplement 1, NUREG-0737 (Vol. 2)."

2. Letter from H. B. Tucker (DPC) to H. R. Denton (NRC) with attachment, dated October 18, 1984.

3. Safety Evaluation of "Abnormal Transient Operating Guidelines," Generic Letter 83-31, September 14, 1983.

TABLE 1

SAFETY FUNCTION VARIABLES

PROVIDED FOR OCONEE SPDS

Safety Function	
Subcriticality	Neutron Flux Channels Control Rod Position Reactor Trip Signal Control Rod Drive Breaker Position
Inadequate Core Cooling	Loss of subcooling in the hot legs Loss of subcooling at core exit Core Exit Thermocouple Temperature
Heat Sink	Steam Generator Level Steam Generator Pressure High Pressure Injection System Low Pressure Injection System Main Feedwater System Condensate System Emergency Feedwater System Turbine Bypass System Low Pressure Service Water System Condenser Circulating Water System
RCS Integrity	RCS Pressure RCS Temperature Pressurizer Level Steam Generator Level Steam Generator Pressure Reactor Building Radiation Steamline Radiation Condenser Air Ejector Off-Gas Radiation
Containment Integrity	Containment Pressure Containment Radiation Containment H_2 Concentration Containment Isolation Containment Cooling System Containment Spray System Low Pressure Service Water System
RCS Inventory	Pressurizer Level Letdown Storage Tank Level Borated Water Storage Tank Level Reactor Building Sump Level *

*Reactor Vessel and Hot Leg Level to be added.